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ORIGINAL ARTICLES

Electrochemical Glucose Biosensor of Platinum Nanospheres Connected by Carbon Nanotubes

Jonathan C. Claussen, M.S.,[1,2,3] Sungwon S. Kim, Ph.D.,[1,4] Aeraj ul Haque, M.S.,[1,2,3] Mayra S. Artiles, B.S.,[1,4] D. Marshall Porterfield, Ph.D.,[1,2,3,5] and Timothy S. Fisher, Ph.D.[1,4]

Abstract

Background:

Glucose biosensors comprised of nanomaterials such as carbon nanotubes (CNTs) and metallic nanoparticles offer enhanced electrochemical performance that produces highly sensitive glucose sensing. This article presents a facile biosensor fabrication and biofunctionalization procedure that utilizes CNTs electrochemically decorated with platinum (Pt) nanospheres to sense glucose amperometrically with high sensitivity.

Method:

Carbon nanotubes are grown *in situ* by microwave plasma chemical vapor deposition (MPCVD) and electrochemically decorated with Pt nanospheres to form a CNT/Pt nanosphere composite biosensor. Carbon nanotube electrodes are immobilized with fluorescently labeled bovine serum albumin (BSA) and analyzed with fluorescence microscopy to demonstrate their biocompatibility. The enzyme glucose oxidase (GO_X) is immobilized onto the CNT/Pt nanosphere biosensor by a simple drop-coat method for amperometric glucose sensing.

Results:

Fluorescence microscopy demonstrates the biofunctionalization capability of the sensor by portraying adsorption of fluorescently labeled BSA unto MPCVD-grown CNT electrodes. The subsequent GO_X–CNT/Pt nanosphere biosensor demonstrates a high sensitivity toward H_2O_2 (7.4 μA/mM/cm^2) and glucose (70 μA/mM/cm^2), with a glucose detection limit and response time of 380 nM (signal-to-noise ratio = 3) and 8 s ($t_{90\%}$), respectively. The apparent Michaelis–Menten constant (0.64 mM) of the biosensor also reflects the improved sensitivity of the immobilized GO_X/nanomaterial complexes.

Conclusions:

The GO_X–CNT/Pt nanosphere biosensor outperforms similar CNT, metallic nanoparticle, and more conventional carbon-based biosensors in terms of glucose sensitivity and detection limit. The biosensor fabrication and biofunctionalization scheme can easily be scaled and adapted for microsensors for physiological research applications that require highly sensitive glucose sensing.

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Author Affiliations: [1]Birck Nanotechnology Center, Purdue University, West Lafayette, Indiana; [2]Bindley Bioscience Center—Physiological Sensing Facility, Purdue University, West Lafayette, Indiana; [3]Department of Agricultural and Biological Engineering, Purdue University, West Lafayette, Indiana; [4]School of Mechanical Engineering, Purdue University, West Lafayette, Indiana; and [5]Weldon School of Biomedical Engineering, Purdue University, West Lafayette, Indiana

Abbreviations: (BSA) bovine serum albumin, (CNT) carbon nanotube, (FITC) fluourescein isothiocyanate, (GO_X) glucose oxidase, (H_2O_2) hydrogen peroxide, (MPCVD) microwave plasma chemical vapor deposition, (NADH) nicotinamide adenine dinucleotide, (PAA) porous anodic alumina, (PBS) phosphate buffered saline, (Pt) platinum

Keywords: carbon nanotubes, fluorescence, glucose biosensor, platinum nanospheres

Corresponding Author: Timothy S. Fisher, Ph.D., Purdue University, Birck Nanotechnology Center, 1205 W. State Street, West Lafayette, IN 47907-2057; email address tsfisher@purdue.edu